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A HOLLOW CHAMBER COMPOSITE ARTICLE

CROSS REFERENCE TO RELATED PATENT APPLICATION

The present patent application claims the right of priority under 35 U.S.C. §119 (a)-(d) of German Patent Application No. 103 17 217.3, filed April 15, 2003.

FIELD OF THE INVENTION

The invention provides a hollow chamber composite component consisting of at least one one-part or multi-part hollow section made of metal or plastic and optionally a one-part or multi-part support element made of metal or plastic residing inside of the hollow section, wherein the support element and the hollow section and/or the hollow section parts are positively bonded (fixedly attached) to each other by means of a thermoplastic material. The invention also provides a process for producing such a hollow chamber composite component.

BACKGROUND OF THE INVENTION

Hollow chamber composite components are disclosed, for example, in DE 198 48 516. A molded-on thermoplastic material is used to bond the half-shell to a covering sheet or top shell. For this purpose, the half-shell and the covering sheet have, for example, a surrounding border which is provided with openings in which riveted joints made of molded-on plastic, for example, are mounted. As an alternative, or in addition thereto, beads can also be provided at which a shear-resistant, positive bond can also be produced by means of a molded-on plastic material. In addition, other processes for bonding two or more molded parts, such as welding, glueing, edge-forming, clinching, riveting, which can be used separately or in combination to bond molded parts, are disclosed in DE 198 48 516.

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Hollow chamber light-weight components, which can withstand high mechanical stresses, are used, for example, in the construction of vehicles.

SUMMARY OF THE INVENTION

The present invention is based on the object of providing a hollow chamber composite component in which the molded parts are bonded together with high jointing accuracy. The hollow chamber composite components are intended to be produced in a very simple process.

In accordance with the present invention there is provided, a hollow chamber composite article (14, 14') comprising:

(a) a section (10, 10') having exterior (17, 17') and interior (20, 20') surfaces and a hollow interior (23) (referred to herein as a "hollow section"), said section comprising at least one part (1, 1') and being fabricated from a material selected from the group consisting of metal, plastic and combinations thereof;

(b) optionally a support element (5) comprising at least one part and being fabricated from a material selected from the group consisting of metal, plastic and combinations thereof, said support element (5) residing within the hollow interior (23) of said section (10') and abutting at least a portion of the interior surfaces (20, 20') of said section; and

(c) thermoplastic material (4, 8) molded onto at least a portion of the exterior surfaces (17, 17') of said section (10, 10'),

wherein at least one of,

(i) the parts (1, 1') of said section (10, 10') are fixedly attached (positively bonded) together by means of plastic deformation of at least one part of said section (e.g., against, into a bead / depression, or through a perforation in another section part) during molding of thermoplastic material onto at least a portion of the exterior surfaces (17) of said section (10, 10'),

and

(ii) said support element (5) is fixedly attached (positively bonded) to at least one part (1, 1') of said section (10') by means of plastic deformation of at least one part (1, 1') of said section (10') against at least a portion (7) of said support element (5) during molding of thermoplastic material onto at least a portion of the exterior surfaces (17, 17') of said section (10').

The features that characterize the present invention are pointed out with particularity in the claims, which are annexed to and form a part of this disclosure. These and other features of the invention, its operating advantages and the specific objects obtained by its use will be more fully understood from the following detailed description and accompanying drawings in which preferred embodiments of the invention are illustrated and described.

Unless otherwise indicated, all numbers or expressions, such as those expressing structural dimensions, quantities of ingredients, etc. used in the specification and claims are understood as modified in all instances by the term "about."

BRIEF DESCRIPTION OF THE DRAWING FIGURES

Figure 1 is a sectional representation of a hollow chamber composite component according to the invention, that includes two half-shells (1, 1') which are positively bonded (fixedly attached) together by at least one pair of abutting edge regions (26);

Figure 2 is a sectional representation of a hollow chamber composite component according to the invention that includes two half-shells or parts (1, 1') and a support structure or element (5) residing within the hollow

interior (23) of the section (10'), and where the support structure (5) is fixedly attached to each half-shell / part (1, 1') of the hollow section (10'); and

Figure 3 is a sectional representation of an abutting edge region (26') in which the edge region of one section part includes a bead (or depression) (29) into which a portion (32) of the edge region of the other abutting edge region is plastically deformed, thereby fixedly attaching the section parts together.

In Figures 1 through 3, like reference numerals designate the same operations and components.

DETAILED DESCRIPTION OF THE INVENTION

The hollow chamber composite component according to the invention has a one-part or multi-part hollow section made of metal or plastic. The hollow section may be open, e.g. in the form of a half-shell or a roll section, or closed, e.g. in the form of a tube with any cross-section, for example a round or rectangular cross-section. A one-part hollow section may be, for example, a tube. A multi-part hollow section may be composed, for example, of two half-shells or a half-shell and a covering sheet. The hollow section may have any three-dimensional shape. In addition, several hollow sections may be bonded to each other and thus form a complex three-dimensional hollow structure, e.g., with branches. If the hollow section is made up of several parts, then the hollow section parts (e.g., two half-shells) are bonded together positively by means of a molded-on thermoplastic material.

Inside the hollow section according to the invention, there is optionally at least one support element made of metal or plastic. The support element

is positively bonded to the interior of the hollow section by means of a molded-on thermoplastic material. The support element may be a one-part or a multi-part structure. The support element may also be produced either as a solid structure or one having recesses (e.g., cavities, channels or the like). As a result of the actual geometry of the support element, for example one with a cross-section in the shape of a cross, the support element may divide the hollow section into several channels which may be used, for example, as cable ducts or air ducts. More particularly, the exterior surfaces of the support element and the interior surfaces of the hollow section together define a plurality of channels. At least a portion of the support element may be adjacent to the internal wall of the hollow section.

The support element may be used, for example, to support the hollow section against the injection pressure of the molded-on plastic material, because undesirable plastic deformations may occur during the molding-on of further molded parts or overspraying of the hollow section. In this case, the support element is preferably adjacent to the internal wall only in the regions where further molded parts are to be externally molded-on to the hollow section or the hollow section is to be oversprayed. The geometry of the support element is chosen so that it exerts a supporting function from within the hollow section, against the injection pressure of the plastic material. However, the support element may also be used to improve the rigidity and strength of the hollow section.

According to the invention, the shear-resistant, positive bonding together of the support element and the hollow section and/or hollow section parts is achieved by plastic deformation of at least one hollow section part by molding-on the thermoplastic material. If the hollow section has several parts and consists, for example, of two half-shells or a half-shell and a

covering sheet, then the hollow section parts are bonded to each other, for example, in the edge region in which the two section parts are located above each other or alongside each other. In this case one of the section parts has openings and/or beads in the edge region which are covered by the edge region of the other section part. Likewise, one or other of the section parts may alternately have openings and/or beads which are each covered by the other section part. As a result of the injection pressure during molding-on of the thermoplastic material, the part of the section in the region of the opening which covers the opening is plastically deformed by being pushed into the opening. The injection pressure of the plastic is great enough for the section part made of metal or plastic to become deformed in the region of the injection point. For this purpose, the mold cavity in the injection mold has a cavity in the region of the opening into which the molded-on plastic cannot enter. As a result of plastic deformation, a shear-resistant, positive bond is produced between the two section parts.

In an embodiment of the hollow chamber composite article of the present invention and with reference to Figures 1 and 3, the hollow section (10) includes at least two parts (e.g., 1 and 1') each having an edge region (2, 2'), at least a portion of the edge region of each section part abuts at least a portion of the edge region of another section part, and together forms at least one abutting edge region (26, 26'). With regard to each abutting edge region (26, 26'), at least one edge region (2') has at least one aperture (3) and/or at least one bead or depression (29, of Figure 3). The edge region abutting the aperture (3) and/or bead (29) is plastically deformed through the aperture (3) and/or plastically deformed into the bead (29) during molding of thermoplastic material onto at least a portion of the abutting edge region (26, 26'). Such plastic deformation with an

abutting edge region serves to fixedly attach the parts of said section together (when the hollow section is composed of two or more parts).

In a preferred embodiment, the hollow section has two parts and the two hollow section parts are located alongside each other in an edge region, wherein one of the hollow section parts has openings and/or beads in the edge region and the other hollow section part is plastically deformed in the region of the openings and/or beads due to molding-on of on the thermoplastic material.

In the case of hollow section parts made of metal or metal alloys, wall thicknesses of the order of magnitude up to 2 mm (e.g., from 0.4 to 2 mm) can be used for composite components according to the invention. In the case of composite components made of a plastic, the wall thickness may even be of the order of magnitude up to 4 mm (e.g., from 0.3 to 4 mm). In addition, it is also possible, with high injection pressures, of the order of magnitude of up to 2000 bar and/or relatively thin molded parts, e.g., those made of steel sheeting with a thickness of 0.4 to 1 mm, to plastically deform the two molded parts together, which are lying on top of each other or alongside each other (i.e., abutting each other) in the edge region, without openings and/or beads being provided in the two molded parts (e.g., as depicted with abutting edge regions 35 of Figure 2).

The support element can be bonded to the hollow section in a similar way. In this case, the support element is not adjacent to the internal wall of the hollow section in the region of plastic deformation, but has, for example, a hollow cavity in the form of a channel, a recess or the like. When molding-on the plastic material from outside, the hollow section is plastically deformed in the region of the recess in the support element by the hollow section being pushed into the recess or the like.

With reference to Figure 2, the support element (5) may include at least one recess, such as channel (7), and a portion (9, 9') of the hollow section (10') is plastically deformed into the recess during molding of thermoplastic material (8) onto at least a portion of the exterior surfaces (17, 17') of section (10'). Such plastic deformation of the hollow section (10') into recess / channel (7) of internal support element (5) serves to fixedly attach support element (5) and the hollow section (10') together.

The hollow section with support element according to the invention can be partly or completely encapsulated by injection molding. The support element then protects the hollow section from collapsing or from unintentional deformation during molding-on of the plastic.

Preferred metals for the molded parts are steel, nickel, chromium, iron, copper, zinc, titanium, aluminum and magnesium as well as alloys of these metals.

Preferred plastics for the molded parts are non-reinforced, reinforced and/or filled thermoplastic materials, e.g. polycarbonate (PC), thermoplastic polyurethane (PU), polyesters, in particular polyethylene terephthalate (PET), polystyrene (PS), syndiotactic polystyrene, acrylonitrile-butadiene-styrene (ABS), polypropylene oxide (PPO), polysulfone (PSO), polyphenylenesulfide (PPS), polyimide (PI), polyether ether ketone (PEEK), polyamide (PA), polybutylene terephthalate (PBT), polypropylene (PP), polyethylene (PE) or a mixture of these plastics.

Suitable thermoplastic materials for positively bonding the molded parts together include in particular a non-reinforced, reinforced and/or filled plastic material based on polyamide (PA), polyesters, in particular

polyethylene terephthalate (PET), polybutylene terephthalate (PBT), polystyrene (PS), syndiotactic polystyrene, acrylonitrile-butadiene-styrene (ABS), thermoplastic polyurethane (PU), polyolefins, in particular polypropylene (PP), polyethylene (PE), polycarbonate (PC), polypropylene oxide (PPO), polysulfone (PSO), polyphenylenesulfide (PPS), polyimide (PI), polyether ether ketone (PEEK) or a mixture of these plastics.

The invention also provides a process for producing a hollow chamber composite component consisting of at least a one-part or multi-part hollow section made of metal or a plastic and optionally a one-part or multi-part support element made of metal or plastic inside the hollow section, wherein the support element and the hollow section and/or hollow section parts are positively bonded together by means of a thermoplastic material, characterised in that the support element is bonded to the hollow section and/or hollow section parts due to plastic deformation of at least one hollow section part during molding-on of the thermoplastic material.

Positive bonding together of the support element and the hollow section and/or hollow section parts is preferably performed in one process step with molding-on of one or more molded parts to the hollow section. Thus, in this embodiment of the process, both process steps, positive bonding and the molding-on of further molded parts, are performed in one process step. Further molded parts which may be molded-onto the hollow chamber composite component preferably consist of a plastic material, e.g. non-reinforced, reinforced and/or filled thermoplastic materials, e.g. polycarbonate (PC), thermoplastic polyurethane (PU), polyesters, in particular polyethylene terephthalate (PET), polystyrene (PS), syndiotactic polystyrene, acrylonitrile-butadiene-styrene (ABS), polypropylene oxide (PPO), polysulfone (PSO), polyphenylenesulfide (PPS), polyimide (PI), polyether ether ketone (PEEK), polyamide (PA), polybutylene

terephthalate (PBT), polypropylene (PP), polyethylene (PE) or a mixture of these plastics or metal, e.g. steel, nickel, chromium, iron, copper, zinc, titanium, aluminum and magnesium as well as alloys of these metals.

The hollow chamber composite component according to the invention has the advantage that the molded parts are bonded together with high accuracy and reproducibility so that there is no need to adjust the jointing positions with respect to each other. The accuracy is greater than when using a separate jointing technique, such as welding or riveting operations. The process according to the invention for producing a hollow chamber composite component also has the advantage that bonding the section parts together and bonding the support element to the hollow section and also the molding-on of further molded parts takes place in one working step. Since the support element simultaneously protects the hollow section from undesirable plastic deformation during encapsulation by injection molding with a plastic material or during the molding-on of further molded parts, other precautions to prevent deformation of the hollow section do not also have to be taken, such as e.g. the insertion of a solid core to support the hollow section, this having to be removed again after the molding-on process.

The invention is explained in more detail, by way of example, as follows with reference to the attached drawings.

Figure 1 shows a detail from a hollow section 10 made from two half-shells 1, 1', e.g. from a metal such as steel, nickel chromium, iron, copper, zinc, titanium, aluminum and magnesium or alloys of these metals or from a non-reinforced, reinforced and/or filled thermoplastic material such as polycarbonate (PC), thermoplastic polyurethane (PU), polyesters, in particular polyethylene terephthalate (PET), polystyrene (PS), syndiotactic

polystyrene, acrylonitrile-butadiene-styrene (ABS), polypropylene oxide (PPO), polysulfone (PSO), polyphenylenesulfide (PPS), polyimide (PI), polyether ether ketone (PEEK), polyamide (PA), polybutylene terephthalate (PBT), polypropylene (PP), polyethylene (PE) or a mixture of these plastics. The half-shells 1, 1' have a bent edge region 2, 2'. One of the half-shells 1' has an opening 3 in edge region 2'. When molding-on and encapsulating the edges using thermoplastic material 4, a portion of the edge region 2 of half-shell 1 is pushed into opening 3 as a result of the injection pressure, and a plastically deformed portion 6 (a plastically deformed bead) is formed. In this way the two half-shells are bonded positively together in a shear–resistant manner.

Figure 2 (where the same or similar components are given the same reference numbers) shows a hollow chamber composite component 10' consisting of two half-shells 1, 1' and a support element 5 inside hollow section 10'. The half-shells 1,1' consist, for example, of a metal such as steel, nickel chromium, iron, copper, zinc, titanium, aluminum and magnesium or alloys of these metals or of a non-reinforced, reinforced and/or filled thermoplastic material such as polycarbonate (PC), thermoplastic polyurethane (PU), polyesters, in particular polyethylene terephthalate (PET), polystyrene (PS), syndiotactic polystyrene, acrylonitrile-butadiene-styrene (ABS), polypropylene oxide (PPO), polysulfone (PSO), polyphenylenesulfide (PPS), polyimide (PI), polyether ether ketone (PEEK), polyamide (PA), polybutylene terephthalate (PBT), polypropylene (PP), polyethylene (PE) or a mixture of these plastics. The support element 5 consists, for example, of a metal such as steel, nickel chromium, iron, copper, zinc, titanium, aluminum and magnesium or alloys of these metals or of a non-reinforced, reinforced and/or filled thermoplastic material such as polycarbonate (PC), thermoplastic polyurethane (PU), polyesters, in particular polyethylene terephthalate

(PET), polystyrene (PS), syndiotactic polystyrene, acrylonitrile-butadiene-styrene (ABS), polypropylene oxide (PPO), polysulfone (PSO), polyphenylenesulfide (PPS), polyimide (PI), polyether ether ketone (PEEK), polyamide (PA), polybutylene terephthalate (PBT), polypropylene (PP), polyethylene (PE) or a mixture of these plastics.

Support element 5 is positively bonded to hollow section 10' in a shear-resistant manner by plastically deformed portions 9, 9' of half-shells 1, 1'. Plastically deformed portions 9, 9' are formed during overspraying (over-molding) of the hollow section 10' using a thermoplastic material 8. In this embodiment, support element 5 possesses recess in the forma of a channel 7. In the region of the channel 7, support element 5 provides no counter-pressure from inside to the injection pressure during molding-on of the plastic material 8 from outside, so that in this region portions 9, 9', the half-shells 1, 1' are pushed (plastically deformed) into channel 7.

Although the invention has been described in detail in the foregoing for the purpose of illustration, it is to be understood that such detail is solely for that purpose and that variations can be made therein by those skilled in the art without departing from the spirit and scope of the invention except as it may be limited by the claims.